PROJECT 6 OVERVIEW
Developing Better Data on Accident Precursors or Leading Indicators

INTRODUCTION

The Bureau of Transportation Statistics (BTS) has developed a *Safety Data Action Plan* that sets forth a number of projects intended to improve the quality, reliability, timeliness, completeness, and utility of safety data across all transportation modes. Project 6 focuses on the identifying relationships between precursors and safety outcomes. In particular, the goal of the project is to develop research studies that might significantly improve our ability to predict safety problems, and to identify data elements essential to predicting transportation injuries and fatalities.

A series of meetings between representatives of the various transportation modes were held in the summer and fall of 2001 and resulted in the development of 17 research topics. After discussions of the relative benefits and costs of each proposal, lists of both short-term and long-term projects were selected for further consideration.

During the fall of 2001, suggestions identified as high priority were developed into formal research proposals. Several well-qualified statisticians were brought in to develop the research protocols, and knowledge-base representatives from the appropriate modes helped establish specific data collection mechanisms and research implementation plans.

Background

During the development of the *Safety Data Action Plan*, it was recognized that in order to justify significant efforts to gather better or new data on accident precursors, there was a need to prove the value of collecting the data. Even if there were significant efforts to gather more complete, accurate data in an area covered by existing data collection processes, the additional cost of this expanded effort would require justification. One possible justification for these additional data collection costs would be compelling evidence of the ability to predict accidents based on information provided by these additional data.

The main objective in Project 6 is to identify accident precursors or leading indicators for further research on hypothesis testing and establishing relationships between risk and predictors. The results of this research can also be used to target or redirect programs for greater effectiveness (i.e., fewer fatalities and injuries).

The working team for this project was composed of staff from the National Safety Council (NSC), Traffic Safety Analysis Systems & Services, Inc. (TSASS), and representatives from each of the modes, who could provide technical input and content-based expertise.

METHOD

Efforts within Project 6 were organized along a series of subprojects and phases. The first of these was a literature review performed by the Volpe National Transportation Systems Center and NSC staff. Other major phases included candidate research project identification, project prioritization, research protocol development, and report preparation.

Volpe Literature Search/Review

The Volpe staff reviewed a number of information sources to compile an Access database of precursor-accident relationships that have been identified or studied. NSC staff then reviewed the documents and identified several potential research projects for further study.

Solicitation of Precursor Ideas

Subsequently, BTS and NSC hosted a series of meetings with team members to solicit suggestions for research into accident precursors. These meetings were attended by staff from each DOT mode and resulted in roughly 20 suggestions for research. A review of the projects revealed several common themes among members of the working team from which combined project descriptions were drawn.

Once a set of candidate projects was formulated, the team was then called on to establish criteria for prioritizing the research suggestions. Eight criteria were adopted. The proposed projects were ranked by all team members based on the criteria listed below. The numbers in parentheses represent the pooled weight out of 100 percent, based on team member balloting:

- *Increased understanding (20%)*
  Does this add to our knowledge? Has it been done before?
- *Cost-effectiveness (15%)*
  Is this worth more than the cost of research or implementation? Consideration of length of research effort.
- *Feasibility of implementation (14%)*
  If it proves a strong relationship, will we implement the results in terms of changes to our data collection?
- *Likely impact (16%)*
  Will this make a difference with respect to safety and /or policy?
- *Anticipated cost of research (8%)*
  Is this likely to be expensive or inexpensive to research?
- *Adaptability to other/multiple modes (11%)*
  Do you think multiple modes could use the results of this research?
- *Cross-function (7%)*
  Would the results be used by multiple functions (operations, planning, enforcement)?
- *External consumer (9%)*
  What will be the reaction by outside stakeholders (industry, states, etc.)?

Review and Refinement

During the period when the proposed projects were ranked by the working team, additional information on data availability was collected. In particular, the project sponsors were asked to provide information on the likely source of data to be used in the proposed research. If that source existed, they were asked to provide information about the accessibility, completeness, and reliability of the data. If there was no current source for the data, they were asked to suggest how the data might be collected, and to provide some insight about the potential difficulties in obtaining data. The description of each project was then updated and expanded to the extent possible.

RESULTS

Proposed Research Projects that evaluate the relationship between a specific precursor and a safety outcome fall within the following four categories.

Evaluation of a Type of Data or Method of Collection

Several of the proposed projects were directed toward evaluating the general type of data or a method of gathering data to predict accidents.

"Text Mining to Establish Sequence of Events" addressed the general sense that the sequence of events might be an excellent predictor of accidents, but recognized that this information is seldom coded within safety datasets. However, many safety data files contain narrative information that might indicate the sequence of events, if properly processed. Text mining is an analytical tool that draws on the ability of computer programs to look for patterns within large volumes of text information. This project, if pursued, would look at narrative information in the accident files of several modes to establish if, indeed, text mining technology can generate a set of discrete events, and sequence those events as well as a human might. Examples of the types of data files that would be utilized included: narratives of traffic crashes from police agencies that use laptops (text files) to record traffic accident data as well as similar data from the aviation and maritime modes.

Another project, entitled "A Human Factors Analysis of Precursors Associated with Incidents/Accidents," attempts to apply the JANUS approach to classifying precursors to maritime accident information. By incorporating aspects of Reason's "Swiss Cheese" model of human error, the Human Factors Analysis and Classification System (HFACS) developed by Shappell and Wiegmann, and the HERA model used by EUROCONTROL, a common taxonomy can be developed for the examination of incidents within multiple domains.

The third project, entitled "Value of Volunteered Safety Information as Precursors," draws on experience in the aviation industry. It calls for a detailed review and analysis of information obtained from existing voluntary reporting systems where hazardous situations are reported to an authority by vehicle operators or the public. The goal of this project is to establish the reliability and utility of data obtained through these systems in identifying potential accident precursors.

Other projects within this topic area include:

- retrospective interview and survey information about operator distractions, misunderstandings, etc., that might have increased the likelihood of operator error, resulting in an accident, or near-accident;
- an assessment of the data needs for GIS systems that support safety analysis;
- documentation of safety successes as well as failures (i.e., where a safety design succeeded in mitigating the severity of an incident); and
- various forms of data modeling to establish potential for accidents.

Safety Culture Analysis

Establishing a methodology for documenting and assessing the "Safety Culture" of operators and companies was recommended by several modes. These projects focused on attributes of the operator (both the driver and the company), which might allow the characterization of accident risk. An

example was given of a small charter flight operation, trucking company, or fishing operation that was owner-operated and the possibility that the combined workload of being both the driver and manager of a small company might increase the likelihood of accidents.

The project with the highest rating in this group was proposed by the Federal Aviation Administration, entitled: "Organizational Safety Culture and Other Indicators of Accident Risk." Other projects with similar focus, but slightly different approaches, include the NIOSH proposal "Using an Indexing System to Identify Precursors for Vehicle Crashes, Injuries and Deaths" and the Maritime Administration proposal "Study Feasibility of Possible Profiling Systems." These projects attempt to establish measures or classification criteria that allow evaluation of a commercial operator for potential accident involvement. All of these projects received strong support across modes, and they appeared to have good potential for technology transfer from one mode to another.

Specific Precursor-Outcome Relationships

The project with the highest rating in this category focused on workload as a specific precursor to accidents. Other projects within this group addressed the following precursors:

1. experience and training as predictor of hazardous materials incidents,
2. noise levels and distraction,
3. social needs and nocturnal work activity,
4. tracking undeclared hazardous materials shipments,
5. traffic intensity at the sector level, and
6. driving records as a predictor of crash involvement.

The first three are specific risk factors that might be considered under "Safety Culture" efforts. Projects 4 and 5 were specific to a particular USDOT mode. The last project investigates the potential link between sudden changes in driving patterns and increased likelihood for causing accidents.

Technology Transfer

The project entitled "Use of Flight Data Recorder Information to Predict Accidents" was developed on the concept that data from vehicle data recorders can be used to establish patterns of operation, such as evasive or abrupt maneuvers that would be potential predictors of accidents. The growing use of computer technology for vehicle control and monitoring in all modes can make such analysis possible. Modes that can most benefit from this study include Aviation, Maritime, and Highway.

GENERAL CONCLUSIONS AND NEXT STEPS

The proposed research efforts covered a wide range of specific accident types and transportation environments. Results of such research efforts have the potential to make significant contributions to the field of transportation safety. Several of the proposed projects can be done utilizing existing data sources in a relatively short time frame, while others can be started with minimal new data collection efforts. However, most of the proposed projects will likely entail a two-year time commitment.